sented, the one close to, and the other at a distance from the source of heat. The object in the one room near to the source having the large heating surface was almost enveloped in rays, while that in the second received rays only in one direction, the former therefore being much more heated than the latter. This difference did not occur when the two globes at a distance from the two sources of heat were compared. The law that the rays of heat diminished in the inverse ratio of the square of the distance was only correct as regards small but intense sources of heat, whilst the decrease of radiant heat took place in a much higher proportion in the case of large sources of heat of low intensity. This clearly proved that for the purpose of warming rooms by means of radiation, it was important that the heat should be concentrated in an intensely hot focus, as was the case in nature, our earth being warmed in this way by the radiant action of the sun.

ON THE EFFECT OF HEAT IN CHANGING THE STRUCTURE OF CRYSTALS OF POTASSIUM CHLORATE

IT was observed some time ago by M. Mallard (*Bulletin de la Société Minéralogique*, 1882, p. 214) that certain crystals, such as boracite and potassium sulphate, have their crystallographic character profoundly modified by exposure to a high temperature, and that in the case of potassium sulphate a number of hemitrope plates are thus formed.

Now, potassium chlorate, while it does not belong to the same crystal-family as potassium sulphate, shows a still more inveterate tendency to produce twins (such as would assuredly drive a Malthus to despair). It was therefore an obvious inference that heat might produce a similar physical change in this substance, although I have not been able to find any account of the experiment having been tried. The decrepitation of crystals of potassium chlorate, when heated, has of course been noted; but the wreck of the crystal has been always rather inadequately explained as due to the vaporisation of included films of water.

A clear transparent crystal of potassium chlorate, from which the inevitable twin plate had been ground away so as to reduce it to a single crystal-film about 1 mm. in thickness, was placed between pieces of mica and laid on a thick iron plate. About 3 cm. from it was laid a small bit of potassium chlorate, and the heat of a Bunsen burner was applied below this latter, so as to obtain an indication when the temperature of the plate was approaching the fusing-point of the substance (359° C., according to Prof. Carnelley). The crystal-plate was carefully watched during the heating, but no decrepitation took place, and no visible alteration was observed, up to the point at which the small sentinel crystal immediately over the burner began to fuse. The lamp was now withdrawn, and when the temperature had sunk a few degrees a remarkable change spread quickly and quietly over the crystal-plate, causing it to reflect light almost as brilliantly as if a film of silver had been deposited on it. No further alteration occurred during the cooling; and the plate, after being ground and polished on both sides, was mounted with Canada balsam between glass plates for examination. Many crystals have been similarly treated with precisely similar results; and the temperature at which the change takes place has been determined to lie between 245° and 248°, by heating the plates upon a bath of melted tin in which a thermometer was immersed. With single crystal-plates no decrepitation has ever been observed, while with the ordinary twinned plates it always occurs more or less violently, each fragment showing the brilliant reflective power above noticed. Doubtless the decrepitation is due to the wrenching asunder of the hemitrope plates, caused by their unequal expansion by heat in different directions.

The following brief account will show the nature of the changes which the crystal has undergone:—

(1) Examined in common white light, the ordinary crystals of potassium chlorate reflect no more light, either superficially or internally, than a plate of glass, in whatever position they are viewed.

The altered crystals, when similarly examined, reflect little light at small angles of incidence, but at all angles greater than about 10° they reflect light with a brilliancy which shows that the reflection must be almost total. This reflective power does not seem to be materially greater at high angles of incidence. When the plate is turned round in its own plane, two positions are found, differing in azimuth by 180°, in which the crystal reflects no more light than an ordinary crystal under the same conditions. In these cases the plane of incidence coincides with the plane of crystallographic symmetry.

The reflected beam is slightly iridescent; and when the plate is held obliquely and examined with a magnifier, a striated faintly-coloured structure is observable, resembling that of watered silk or mother-of-pearl. The coloured bands always lie parallel to the plane of symmetry. When the reflected light is examined with a spectroscope, it is found to give a rather complicated spectrum containing numerous narrow absorption-bands. In some specimens these bands are fairly straight and regular, but in most cases they are rather wavy, and vary in thickness in different parts of their length, appearing somewhat like the interlacing twigs in a bundle of sticks. As the angle of incidence is increased, these bands move towards the more refrangible end of the spectrum, while others appear and join in the procession.

The spectrum of the transmitted light is, of course, strictly complementary to that of the reflected beam; and both of them strongly resemble the spectra given by some of the iridescent crystals described by Prof. Stokes (see NATURE, vol. xxxi. p. 565), and also by many sections of opal and mother-of-pearl, and by films of decomposed glass.

(2) When examined in a parallel beam of plane-polarised light, the ordinary crystals show little or no colour, unless held so that the light passes nearly in the direction of the optic axes, when the usual broad, rather faintly-coloured bands are seen. The altered crystals, on the contrary, give in all positions (except when the light passes through nearly normally, or when the plane of polarisation is either parallel or perpendicular to the plane of symmetry) a most complicated and brightly-coloured pattern, resembling that which is shown by many of the complicated macled crystals of amethystine quartz, which vary, like patterns on watered silk, with slight changes in the direction of incidence of the light.

(3) When examined in a micro-polariscope, in plane-polarised, highly convergent white light, the ordinary crystals show the usual isochromatic lemniscates surrounding the optic axes, which latter are themselves just visible at the edge of the field. In the altered crystals nothing of the kind is visible, only patches of colour distributed rather irregularly over the field, somewhat like those of certain of Nörremberg's mica-selenite combinations.

(4) When homogeneous (sodium) light was substituted for white light in the micro-polariscope (an expedient which is of great use in simplifying and giving definiteness to the phenomena shown by crystals), the remarkable nature of the structural change which heat had caused was much more clearly apparent. The ordinary crystals simply showed the usual multitude of curved isochromatic bands symmetrically arranged round the optic axes and filling the whole field. The altered crystals showed nothing of the kind; but a set of hyperbolas appeared—the form of the isochromatic curves of extremely high order which are given by biaxial crystals when the directions of the optic axes make a very large angle with the normal to the surface of the plate (see Verdet, *Œuvres*, vol. vi. pp. 172-175). These hyperbolas are not rectangular, thus proving that the optic axes do not lie in the plane of the plate (as in the case of cleavage plates of selenite); but they so nearly do this that I could not, even by immersing the plate in oil, satisfactorily determine their precise position. The bands are rather irregular and shifty, as is usual in composite macles; in some parts of a crystal they may appear as the central portions of a lemniscate-system.

(5) It seemed desirable to examine the effect of heat upon the crystal during its progress, so as to determine whether the change of structure takes place at the period of the formation of the reflective layer. For this purpose a polished plate of potassium chlorate was clasped in a copper holder (like that used for plates of selenite in Mitscherlich's well-known experiment), so that it could be placed in the field of the polariscope and examined while its temperature was gradually raised by the application of a lamp-flame to the outer extremity of the holder.

The ordinary set of isochromatic curves lasted nearly unchanged for some time as the temperature rose, but at a certain point they faded away like a dissolving view; and then out of the confusion there emerged the set of hyperbolas above mentioned, which grew in definiteness and regularity, but did not

otherwise alter until the field quickly became dark owing to the fusion of the crystal. This seems to indicate that the change in structure begins quite independently of the formation of the reflective layers, the latter being only an incident occurring at a particular stage of the cooling.

(6) It would seem that something of the following kind happens to the crystal. It is, of course, anisotropic in structure, and the effect of heat is to set up a molecular strain which at a certain point of temperature causes so strong a shearing action between nearly contiguous layers of the substance that whole rows of crystal elements lying between these layers are rolled over, as it were, by the "couple" applied to them, until they take up their "second positions of equilibrium," as M. Mallard would say (see his paper "Sur la Théorie des Macles," *Bull. Soc. Min.*, December 1885, p. 467). If these latter positions were such as to bring the *obtuse* bisectrices (supplementary lines) into parallelism with a normal to the main plate, the occurrence of the hyperbolas above described would be fully accounted for. Such an action would be of the same general character as that which takes place in calc-spar when macles are being developed in it by Reusch's method; viz. by carefully compressing a crystal of it in a definite direction (*Pogg. Ann.*, vol. cxxxii. p. 445), I have succeeded by properly regulating the direction and amount of the pressure in making spar-macles containing numerous "planes of sliding" (*Gleitflächen*, as Prof. Reusch calls them), which reflect light with a pearly lustre, and almost as brightly as the potassium chlorate macles described above.

It has yet to be explained, however, why the intense reflective power does not show itself during the process of heating, when the tilting over of the crystals would certainly take place, and not until a particular stage of the cooling is reached. I am inclined to believe that this may be due to the substance acquiring a certain amount of plasticity at high temperatures, such as has been observed by M. Mallard in crystals of nitre under similar circumstances. This may prevent any loss of optical continuity until a certain critical point in the cooling has been reached; and at this point the displaced crystal elements suddenly part company with their unaltered neighbours, leaving a numerous series of parallel tubular cavities, precisely like those which are undoubtedly present in calc-spar macles formed by Reusch's method. The opposite sides of these parallelogrammatic cavities may be so near each other that the rays reflected from them may interfere, and give the colours of thin plates corresponding to a rather high order in Newton's scale. Although a large amount of light must escape reflection at any single cavity, yet if the transmitted rays encountered a large number of precisely similar and similarly situated cavities at slightly lower levels in the crystal, the sum of the partial reflections would produce an effect almost equivalent to a total reflection of the original incident ray, and a corresponding deficiency in the amount of light transmitted through the whole plate. The brilliancy of the colours in the light reflected from the well-known films of decomposed glass is accounted for in precisely the same way, and the successive separate films of glass can be easily seen under a microscope at the edges of the compound film, where they only partially overlap.

The fact that no brilliant reflection is observed in and near the plane of symmetry of the crystal may be due to the sides of the cavities in a given horizontal row not lying strictly in the same plane, but being slightly inclined alternately in opposite directions, so as to form a series of anticlinals and synclinals, or ridges and furrows like those of a roof. Thus a beam of light incident in the plane of symmetry would be reflected in directions lying a little to the right and left of this plane, and not in the plane itself. The satin-like appearance of the reflecting layers, already alluded to, would be fully accounted for by such a structure.

The changes above described seem of interest as bearing upon the cause of the strong iridescence of some crystals of potassium chlorate, about which I may have something to say in a future communication.

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Eton College, May 10

SCIENCE IN RUSSIA

THE last volume of the *Memoirs* of the Kharkoff Society of Naturalists (vol. xviii.) contains several papers of interest. All who have had to deal with Acarides, and are acquainted with the difficulties of their classification, will welcome the elaborate memoir, by M. Krendowsky, on the Hydrachnids of Southern Russia. It is not a mere description of forms, with a more or less happy classification, but an elaborate contribution towards the systematic arrangement of this imperfectly-known subdivision. The embryogeny of the Hydrachnids, and especially their larval phase, have received special attention, no satisfactory classification being possible without that preliminary study. It appears also from M. Krendowsky's researches that many Hydrachnids of Southern Russia are really temporary parasites on several insects, mollusks, and sponges, especially when young and in the state of six-footed larvæ. The Hydrachnids of South-Western Russia belong to thirty-five species (nine species each of *Nesæa* and *Arrenurus*, five of *Atax*, and four of *Limnesia*); the author has been led to revise the whole of the classification of the freshwater Acarides, and gives it complete, with analyses of each family, as well as of the very numerous genera.

Another paper of great interest is devoted by the same author to the estuaries of the Bug, Dnieper, and the smaller ones in the neighbourhoods of Kherson and Odessa. This paper is full of the most useful information as to the characters and geological history both of these estuaries and the *limans*, which are now shut off from the sea by their sand-bars, and have become mere elongated salt lakes.

Prof. Lewakowsky contributes to the same volume a paper on the Jurassic limestones of the Crimea, based especially on their micro-structure. It appears that they mostly contain very small debris of corals and rhizopods; they are not coral structures, as was supposed, but have much likeness to what Dana describes as beachsand-rock. Like the clay-slates of the same formation in the Crimea, they have been deposited in a wide basin which extended into Kherson and Ekaterinoslav, and they were composed of materials brought from the south, from a continent which occupied part of what is now submerged by the Black Sea. M. Genjouriste's researches into the microscopical structure of the coal of the Donez Basin are interesting inasmuch as they show that the prevailing materials for the formation of this coal were the higher vascular Cryptogams, and not Algæ, as was sometimes supposed by Russian geologists. Dr. M. Dybowsky's additional note on the Spongilla *Dorvilia stepanovii*, one of the most interesting discovered in Europe, contains a description of the structure of its gemmulæ, with the porous and "cirrous appendages." The note, as also the preceding papers, are accompanied by several plates.

SCIENTIFIC SERIALS

The Quarterly Journal of Microscopical Science, vol. xxvi. part 3, April 1886, contains a memoir on the leeches of Japan, by Dr. C. O. Whitman (plates 17 to 21). A short abstract of this important memoir has been given in our Biological Notes.—Contributions to the embryology of the Nemertea, by Prof. A. A. W. Hubrecht (plate 22). No. 1 is an account of the development of *Lineus obscurus*, Barr. These investigations, already published in the Dutch language, are fully detailed in this paper, and the plate gives the details of the principal results, combined into fifteen diagrammatic tracings. In one section the earliest developmental stages and the derivatives of the primary epiblast; in a second the hypoblast before the shedding of the primary larval integuments; and in a third the mesoblast, are treated of.—On the early development of *Julus terrestris*, by F. G. Heathcote, M.A. (plates 23 and 24). This is the first part of an essay on a subject not treated of by British naturalists since the days of Newport. It treats of the segmentation of the ovum, which shows a remarkable resemblance to that found in Amphipods by Uljanin. The formation of the blastoderm is such as is generally found in tracheate development. The cells, which at the conclusion of the blastoderm formation remain within the yolk, represent the endoderm. The mode of formation of the mesoderm almost exactly resembles that described by Balfour for spiders. In a future paper the author intends describing the further developmental stages of the embryo.—William A. Haswell, M.A., on the structure of the so-called glandular ventricle (*Drüsenmagen*) of Syllis (plate 25). This organ is in reality a well-developed muscular gizzard, and contains no glands in its walls. The muscular elements of the organ present an embryonic character containing as they do a polynucleated core.—Arthur B. Lee, on Carnoy's cell researches (plate 26). While Carnoy's conceptions of the cell body do not materially differ from received views, the author of this paper thinks that sufficient attention has not been given to his labours on the